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AUTHOR	Lewis, Jim
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ABSTRACT

This document features an interdisciplinary activity that combines the study of biological science with music, art, language arts and social studies. These activities are aimed at students in middle school through the first two years of high school. All activities can be conducted in the classroom or outdoors around and/or nearby the school. Sections include "Teacher Guide and Background Reading" and "Biodiversity Activities for Students." (CCM)

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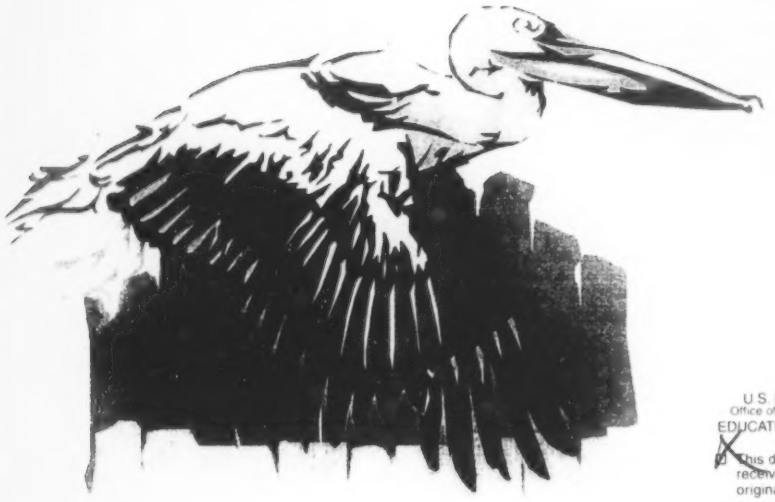
People, Growth, and Endangered Ecosystems:

Exercises in Biodiversity—Grades 6-10



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Part I

Teacher Guide & Background Reading

Grades 6-10

Preface: Note to teachers

How to Use These Materials

This publication — these teachers' notes and reading materials, and the activities that follow — are aimed at students in middle schools and through the first two years of high school. They also may be adapted for other grades. All activities can be conducted in the classroom or in the out-of-doors around the school and nearby.

Biodiversity, while it is a part of biological science, can be studied in music, art, language arts, social studies, *and* in the sciences. As an interdisciplinary activity, *People, Growth, and Endangered Ecosystems*, may be coordinated among teachers of various subjects in whatever grade, or grades, elect to use it or any part of it.

Beginning on page 3, the Introduction and the material that follows should be copied and used as background for classroom reading before the students begin their individual activities. Materials in the bibliography should be easily obtainable, but will require some advance preparation to ensure that they are available for your and student use. Other references, in footnotes and in the text, are to relevant sites on the Internet's World Wide Web.

Sunshine State Standards

These activities will at least partially meet the needs of students under a broad spectrum of the *Sunshine State Standards*, ranging from the natural sciences, through geography and social studies, art, reading, and composition. [1]

[1] See: *Science for All Students: The Florida Pre K-12 Science Curriculum Framework*. Florida Department of Education, 1993. Specifically, Chapter 3, *Strands of Science* and especially Strand 6, *Processes of Life*, Strand 7, *How Living Things Interact With Their Environment*, and Strand 8, *Nature of Science*. Also see: Florida Sunshine State Standards, *http://fcetce.fsu.edu/doe/curric/prek12/frame2.htm*. Also see: *Geography for Life: National Geography Standards*. National Geographic

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Specific standards that might apply include:

Grades 6-8 and 9-12

Language Arts

Reading

Standard 1. The student uses the reading process effectively.

Standard 2. The student constructs meaning from a wide range of texts.

Writing

Standard 1. The student uses the writing process effectively.

Standard 2. The student writes to communicate ideas and information effectively.

Listening, Viewing, Speaking

Standard 3. The student uses speaking strategies effectively.

Science

Processes that Shape the Earth

Standard 1. The student recognizes that processes in the lithosphere, atmosphere and biosphere interact to shape the earth.

Standard 2. The student understands the need for protection of the natural systems on earth.

Processes of Life

Standard 2. The student understands the process and importance of genetic diversity.

How Living Things Interact With their Environment

Standard 1. The student understands the competitive, interdependent, cyclic nature of living things in the environment.

Standard 2. The student understands the consequences of using limited natural resources.

The Nature of Science

Standard 3. The student understands that science, technology and society are interwoven and interdependent.

Social Science

Time, Continuity, and Change

Standard 1. The student understands historical chronology and the historical perspective.

People, Places, and Environment

Standard 2. The student understands the interaction of people and the physical environment.

Note: Others of the Sunshine State Standards might also apply to the exercises in this booklet.

Society and others, 1994.

Introduction to Ecosystems and Biodiversity

Florida's Damaged Ecosystems[2]

Florida is widely known as the home of the threatened Everglades. The damages to its other kinds of wetlands and to some of the spectacular plants and animals that live in them also are well known. But less well known is that the *most imperiled* natural Florida communities are some of its high-and-dry uplands.

Fifteen of 23 types of upland communities in Florida are ranked as *critically imperiled* or *imperiled* by the Florida Natural Areas Inventory, while only 2 of 19 wetland communities are ranked this high. Between 1936 and 1987, Florida lost 88% of its longleaf pine forests. Since 1970, upland hardwood forests have declined by nearly 30%. Forested wetlands have declined by almost 20%. Some 56% of its herbaceous wetlands are gone.

The federal Clean Water Act and most state environmental laws, including Florida's, protect wetlands but give less protection to valuable uplands. Some of Florida's rarest upland communities have been destroyed by creating artificial wetlands to mitigate possible losses of natural wetlands. However, Florida's wetlands losses also are important — and worrisome.

What is an Ecosystem?
An ecosystem is a community of organisms — plants and animals, *including* humans — that interact with one another and the environment in which they live.

What is a Habitat?
The area, or ecosystem, in which an organism or population of organisms normally lives; the ecosystem in which an organism or population is most likely to be found.

The sad numbers for Florida

- **Loss** of virtually all of the dry prairies of Florida to cattle pasture and agriculture.
- **Greater than 98% loss** of pine rockland habitat in southern Florida.
- **92% loss** of mangrove swamp and salt marsh along Indian River Lagoon (Brevard, Indian River, and St. Lucie counties) between 1955 and 1974, from impoundment for mosquito control.
- **88% loss** of longleaf pine forests in Florida from 1936 to 1987.
- **88% loss** of slash pine forests in southwestern Florida from 1900 to 1989.
- **75% loss** of sea grass meadows in Tampa Bay.
- **74.4% of xeric habitats** (scrub, scrubby flatwoods, and sandhills) on southern Lake Wales ridge, Florida, lost to development or degraded.

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[2] Information in this section is taken, in part, from: *Endangered Ecosystems of Florida*, by: Reed F. Noss, University of Idaho; Edward T. LaRoe III, National Biological Service; J. Michael Scott, National Biological Service. [This material, in turn, is extracted from the much larger *Endangered Ecosystemsof the United States*, a publication of the Biological Resources Division of the United States Geological Survey. *http://biology.usgs.gov/pubs/ecosys.h™*. For instructions on downloading the entire report, see *http://bluegoose.arec.r9.fics.gov/nursfiles/HabitatMgmt/EcosystemManagement/EndangeredEcosystems.html*] [For a smaller version of the report, see also: *http://www.uwef.org/legacy/index.htm*.] Florida information can be found at: *http://www.fsu.edu/~cpm/safe/safe.html*.

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- **60-80% loss** of tropical hardwood hammock on the central Florida Keys.
- **64% loss** of Florida sand pine scrub on Lake Wales, Lake Henry, and Winter Haven ridges since settlement.
- **60.5% of flatwoods-swale habitats** on southern Lake Wales Ridge, Florida, lost to development or degraded.
- **56% decline** of marsh (herbaceous wetland) habitat in Florida from 1936 to 1987.
- **51% loss** of fresh-water marshes in southwest Florida from 1900 to 1989.
- **Greater than 50% loss** of pre-settlement wetlands (all types) in Florida.
- **46% loss** of wetlands in Florida between the 1780s and 1980s.
- **33% loss** of sea grass beds that existed in Florida before World War II.
- **27% loss** of total forest area in Florida from 1940 to 1980.
- **25% of bayhead wetlands** on the southern Lake Wales Ridge, Florida, lost to development or degraded.

●●●

While hunting pressures (for food or feathers) are mostly to blame for the most notorious animal extinctions in American (and Florida) history — the passenger pigeon and the Carolina parakeet — there were many other contributing causes. One they shared in common is widespread destruction of the ecosystems (habitats) they needed to survive. And habitat loss — the destruction of the southern old-growth lowland forests — takes most of the blame for the more-recent disappearance of the ivory-billed woodpecker from the southern landscape. These extinctions, as well as the Florida ecosystem declines described above, indicate a serious loss in ***biodiversity*** in Florida and the United States. In fact, alarming losses of biodiversity are occurring worldwide.

What is biodiversity?

Biodiversity (or biological diversity) is the term used to describe *all of the life on earth.* There are about one and a half million named species, but the total number of species on earth is probably between 5 and 15 million. These unknown species will include the insects of tropical forests, the microscopic bacteria, plants and animals that live in the soil, and undiscovered species (small and large) in the oceans.

Scientists look at biodiversity in three ways[3]:

• **Ecosystem** (or habitat) **diversity**, refers to the variety in the places where life exists — coral reefs, longleaf pine forests in the southeast, forested river floodplains, coastal wetlands, and many others. Each broad type of habitat is the home for large numbers of species of plants, animals, and bacteria, many of which may be utterly dependent on that habitat. When a type of habitat disappears, many species disappear with it. Usually, however, an entire habitat does not just vanish. Instead, it is nibbled away, acre by acre, until only small pieces remain — as has happened to the south Florida Everglades, the southern longleaf pine forest, and coastal wetlands in Florida. Elimination of all but small patches of a habitat (forming habitat 'islands' or "patches") is especially damaging. It may eradicate a species with a small range, and threatens species that may be dependent on those species. It also affects those species which need large amounts of intact habitat to survive — such as the Ivory Billed Woodpecker, or the Florida Panther.

Some Benefits of Biodiversity:
A *few* of the benefits of biodiversity include clean water, fresh air, healthy soil, cultural identity, inspiration, peace of mind, food and drink, medicines and vaccines, shelter (timber and other building materials), clothing and fibers, recreation, and energy (wood, sunlight, wind, water).

• **Genetic diversity**: To understand genetic diversity, we need to understand the concept of a "population." A population refers to individuals of a species (for instance, pileated woodpeckers) that live in the same immediate area and which choose mates from among the other pileated woodpeckers which live within that area. The woodpeckers in that population share more of their genes with each other than they do with other pileated woodpeckers from populations which live somewhere else — because individuals in one population rarely mix with those in another. However, while all the pileated woodpeckers within a specific population may share more genetic information (they are more closely related) individuals in all populations of pileated woodpeckers do share the common genetic information that makes them *pileated* woodpeckers, rather than some other kind of woodpecker.

*The **genetic diversity** within a species is in the variety of populations that make it up.* A species reduced to a single population (like the Florida panther — which in reality is a *sub*species)

[3] Expanded from: *Biodiversity*, Ecological Society of America, at: *http://esa.sdsc.edu/biodiv2.htm*

generally contain less genetic diversity than a species that consists of many populations. Panthers, once found over much of North America but now largely limited to western states and the remnant Florida population, once maintained considerable genetic diversity within the species, and some diversity still will exist in the western populations. In Florida, however, the panther (now limited to perhaps 50 individuals) has a very low genetic diversity, a fact which shows up in genetic defects in the animals themselves. Biologists care about the survival of populations, as well as species, because of the unique genetic information contained within populations.

• **Species diversity**, or the total number of different *kinds* of living things on earth, is what most people mean when they talk about biodiversity. Pileated woodpeckers make up a species. Red-bellied woodpeckers are another species. Human beings are another. Pine trees and maples are different species of trees. In principle, individuals from one population of a given species could mate with individuals from another population of the same species. That is a definition of what a species is — a collection of individuals that could, in principle, interbreed and produce offspring which, in turn, can breed. As discussed above, however, individual pileated woodpeckers from different populations within a species rarely interbreed because of geographic isolation. In other words, they never meet. Over a long period, changes within an isolated population of a species may accumulate, eventually creating a *new* species that cannot or will not interbreed with the original species. That is one way that evolution works, as shown by its best-known example — the finches of the Galapagos Islands — or by various closely related species of beach mice on Florida's barrier islands.

We need biodiversity for a number of reasons — not all of them practical or economic ones although it *is* in Florida's environmental and economic interests to conserve its biodiversity. Many of Florida's primary industries — tourism, fisheries, agriculture, forestry, to name four — are directly dependent on maintaining biodiversity. The potential benefits of biodiversity for science, medicine, and agriculture are enormous.

But biodiversity is good for our peace of mind. Just as a dollar value cannot be placed on a beautiful sunset, there is more than economic value involved in the knowledge that we still can find examples of the natural world, or that the longleaf pine forest and red cockaded woodpecker

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still exist, or that the black bear, the manatee, or the panther still live in Florida's out-of-doors. There is even more pleasure to be gained in being able to search for and to *see* these plants and animals in their natural habitat rather than as a specimen or two at a zoo or nature park.

Conserving biodiversity is not just about saving large, visible (warm and fuzzy) endangered species. It is very much about the 'bigger picture.' It is about conserving entire habitats and ecosystems, including the unknown, unattractive species — the bacteria, mosses, ferns, decomposers and scavengers (worms, beetles and fungi), and the other plants and animals that make ecosystems *work*; it is about studying and understanding the complexity of and connections between these ecological relationships up and down the food chain; it is about planning and managing for ecologically sustainable use of our resources; and most importantly, it is about individual and community responsibility.[4]

The United States is one of more than 30 countries which have ratified the International Convention on Biological Diversity[5]. The Convention deals at a global level with the full range of issues surrounding conservation of biological diversity, its sustainable use, and the fair and equitable sharing of the benefits arising from this use.

Even with all its losses, Florida still is among the 'haves' in terms of biodiversity. Our state contains one of the most diverse collections of plants and animals in North America — more even than many countries. Many of Florida's plants and animals are endemic — found nowhere else in North America. And, while there is no doubt that Florida has severe biodiversity problems, unlike many other states, much of Florida's biodiversity is intact. Across Florida, through programs such as the Department of Environmental Protection's Ecosystem Management program,[6] the Florida Game and Fresh Water Fish Commission's schoolyard habitat and wildlife habitat conservation programs,[7] and environmental land-buying and management programs of state agencies and water management districts,[8] governments,

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[4] See: *Toward Environmental Citizenship*, Florida Department of Environmental Protection. 1994.

[5] U.N. Conference on the Environment and Development - 1992.

[6] See *Implementing Ecosystem Management*, Office of Environmental Education, Florida Department of Environmental Protection, 1995.

[7] See: *Closing the Gaps in Florida's Wildlife Habitat Conservation System*, Office of Environmental Services, Florida Game and Fresh Water Fish Commission, 1994.

[8] Save Our Rivers, and Preservation 2000.

community groups, industry and individuals are engaged in wide-ranging activities aimed at conserving biodiversity. But much remains to be done.

Schools also have a vital part to play, by teaching students of the importance of biodiversity to the world around them — including the built-up world they live in. It is today's student who will make tomorrow's decisions on activities that affect biodiversity in Florida, the nation — and the world.

1. Biodiversity in Florida

The fact that Florida is a peninsula with habitats that exist in temperate zones and through the semi-tropical and (almost) to the tropical explains how Florida's broad variety of plants and animals came to be. Important features of Florida's biological diversity include[9]:

- A wide variety of vertebrates — 75 species of mammals, 283 species of birds (*excluding* some migratory species), 127 reptiles, 57 amphibians, and 126 fishes. A high percentage (17%, or 115 kinds of vertebrates) are *endemic* species (species that occur nowhere else in the United States).

- About 3,500 species of vascular plants, of which about 8%, or 280 species are endemic.

- An unknown total number of invertebrate animals (insects, shrimp, coral, spiders, etc.) species, including more than 6,000 aquatic invertebrates, and *at least* three times that number of terrestrial (land based) invertebrates, make Florida their home. More than 410 of these are endemic. The number probably is much higher.

- 118 of the animals — 16 fish, 29 amphibians or reptiles, 36 birds, 30 mammals, and 7 invertebrates are listed by the Florida Game and Fresh Water Fish Commission as *endangered, threatened*, or *species of special concern.*[10]

- The Florida Department of Agriculture lists 496 plants as *endangered, threatened*, or *commercially exploited.*[11]

The Game and Fresh Water Fish Commission's *Gaps* report notes that the "existence of so many endemic species in Florida confers upon us a weighty responsibility . . . in (our) efforts to conserve the diversity of life on earth."

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[9] See: *Closing the gaps*, op cit.

[10] *Official Lists of Endangered or Potentially Endangered Fauna and Flora in Florida*, Florida Game and Fresh Water Fish Commission, June 1994.

[11] ibid.

2. Conserving Florida's Biological Diversity:

Endangered or Threatened Species — Florida, 93 species[12]

Animals - 39 species

Bat, gray — *Myotis grisescens*
Butterfly, Schaus swallowtail — *Heraclides (=Papilio) aristodemus ponceanus*
Caracara, Audubon's crested — *Polyborus plancus audubonii*
Crocodile, American — *Crocodylus acutus*
Darter, Okaloosa — *Etheostoma okaloosae*
Deer, key — *Odocoileus virginianus clavium*
Eagle, bald — *Haliaetus leucocephalus*
Falcon, American peregrine — *Falco peregrinus anatum*
Jay, Florida scrub — *Aphelocoma coerulescens coerulescens*
Kite, Everglades snail — *Rostrhamus sociabilis plumbeus*
Manatee, West Indian (=Florida) — *Trichechus manatus*
Mouse, Anastasia Island beach — *Peromyscus polionotus phasma*
Mouse, Choctawhatchee beach — *P. p. allophrys*
Mouse, Perdido Key beach — *P. p. trissyllepsis*
Mouse, southeastern beach — *P. p. niveiventris*
Mouse, Key Largo cotton — *Peromyscus gossypinus allapaticola*
Panther, Florida — *Felis concolor coryi*
Plover, piping — *Charadrius melodus*
Rabbit, lower keys — *Sylvilagus palustris hefneri*
Rice rat (=silver rice rat) — *Oryzomys palustris natator*
Shrimp, Squirrel Chimney Cave (=Florida cave) — *Palaemonetes cummingi*
Skink, bluetail mole — *Eumeces egreguis lividus*
Skink, sand — *Neoseps reynoldsi*
Snail, Stock island tree — *Orthalicus reses* (not. incl. *nesodryas*)
Snake, Atlantic salt marsh — *Nerodia clarkii teeniata*
Snake, eastern indigo — *Dymarchon corais couperi*
Sparrow, Cape sable seaside — *Ammodramus maritimus mirabilis*
Sparrow, Florida grasshopper — *Ammodramus savannarum floridanus*
Stork, wood — *Mycteria americana*
Sturgeon, Gulf — *Acipenser oxyrhynchus desotoi*
Tern, roseate — *Sterna dougallii dougallii*
Turtle, Kemps (=Atlantic)— *Lepidochelys kempii*
Turtle, green sea — *Chelonia mydas*
Turtle, hawksbill — *Eretmochelys imbricata*
Turtle, leatherback sea — *Dermochelys coriacea*
Turtle, loggerhead sea — *Caretta caretta*
Vole, Florida salt marsh — *Microtus pennsylvanicus dukecampbelli*
Woodpecker, red cockaded — *Picoides borealis*
Woodrat, Key Largo — *Neotoma floridna smalli*

[12]U.S. Fish and Wildlife Service listing of endangered species of animals. *http://www.nwf.org/endangered/listing/index.html* Note: Differs somewhat from Florida list.

Plants — 54 species

Crenulate lead plant — *Amorpha crenulata*
Four-petal pawpaw — *Asimina tetramera*
Florida bonamia — *Bonamia grandiflora*
Brooksville bellflower — *Campanula robinsiae*
Fragrant prickly apple — *Cereus eriophorus* var. *fragrans*
Deltoid spurge — *Chamaesyce deltoides* ssp. *deltoidea*
Garber's spurge — *Chamaesyce garberi*
Pygmy fringe tree — *Chionathus pygmaeus*
Florida golden aster — *Chrysopsis floridana*
Pigeon wings — *Clitoria fragrans*
Short-leaved rosemary — *C. brevifolia*
Etonia rosemary — *C. etonia*
Apalachicola rosemary — *C. glabra*
Avon Park harebells — *Crotalaria avonensis*
Okechobee gourd — *Cucurbita okeechobeensis* ssp. *okeechobeensis*
Beautiful pawpaw — *Deeringothamnus pulchellus*
Rugel's pawpaw — *D. rugelii*
Garrett's mint — *Dicerandra christmanii*
Longspurred mint — *D. cornutissama*
Scrub mint — *D. frutescens*
Lakela's mint — *D. immaculata*
Scrub buckwheat — *Erigonum longifolium* var. *gnaphalifolium*
Snakeroot — *Eryngium cunifolium*
Telephus spurge — *Euphorbia telephoides*
Small's milkpea — *Galactia smallii*
Harper's beauty — *Harperocallis flava*
Highlands scrub hypericum — *Hypericum cumulicola*
Beach jacquemontia — *Jacquemontia reclinata*
Cooley's water willow —*Justacia cooleyi*
Scrub blazingstar — *Liatris ohlingerae*
Pondberry — *Lindera melissafolia*
Scrub lupine — *Lupinus aridorum*
White birds-in-a-nest — *Macbridea alba*
Britton's beargrass — *Nolina brittoniana*
Papery whitlow wart — *Paronchia chartacea*
Key tree cactus — *Pilosocereus robinii (=Cerus r.)*
Godfrey's butterwort — *Pinguicula ioantha*
Lewton's polygala — *Polygala lewtonii*
Tiny polygala - *P. smallii*
Wireweed — *Polygonella basiramia*
Sandlace — *P. myriophylla*
Scrub plum — *Prunus geniculata*
Chapman rhododendron — *Rhododendrom chapmanii*
Miccosukee gooseberry — *Ribes echinellum*
American chaffseed — *Schwalbea americana*
Florida skullcap — *Scutellaria floridana*
Fringed campion — *Silene polypetala*
Gentian pinkroot — *Spigelia gentianoides*
Cooley's meadowrue — *Thalictrum cooleyi*
Wide-leaf warea — *Warea amplexifolia*
Carter's mustard — *W. carteri*
Florida ziziphus — *Ziziphus celata*
Florida torreya — *Torreya taxifolia*
Florida perforate cladonia — *Cladonia perforata*

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3. Benefits of Protecting Biodiversity

Conservation of biological diversity contributes to the development of our spiritual, ethical, and aesthetic values. Few people would express a preference to see a new suburban strip mall take the place of a quiet vista made up of a native forest, or an armored sea wall instead of a broad expanse of beach. Natural landscapes, or pastoral agricultural scenes, are always preferred to the neon-pavement-and-blacktop look of so many Florida cities.

Biological diversity also provides us with food, fiber, medical, agricultural, and industrial products. Our ability to develop new and improved products for the future rests to a great degree upon maintaining biological and genetic diversity. Few of Florida's plant species (for example) have been investigated for their potential usefulness for products or medical drugs. (For example, *Taxol*, a chemical shown to have important cancer-treatment abilities, was discovered in a North American yew which is quite similar to the endangered Florida yew, *Torreya taxifolia*.) Biodiversity also provides and maintains a wide array of ecological *services*: clean water, clean air, fertile soil, food, and shelter. In fact, our economy rests upon these 'free' biodiversity-related services.

Gretchen C. Daily in the introduction to her book, *Nature's Services*[13], ask readers to imagine they were setting up "a happy day-to-day life on the moon" and that the moon somehow already had acquired air and a suitable climate. Even so, she points out, a great deal of work still would be needed to make the moon livable. "(T)he big question would be," she says, "*Which of earth's millions of species do you need to take with you?*" (emphasis added).

She provides a partial list of the services they would have to provide:

- purification of air and water
- mitigation of floods and droughts
- detoxification and decomposition of wastes
- generation and renewal of soil and soil fertility
- pollination of crops and natural vegetation
- control of the vast majority of potential agricultural pests
- dispersal of seeds and translocation of nutrients
- maintenance of biodiversity, from which humanity has derived key elements of its agricultural, medicinal, and industrial enterprise

[13] *Nature's Services*, Gretchen C. Daily, ed. Island Press, 1997. For an important article on the same subject, see: *http://www.sdsc.edu/~ESA/issues.htm*

- protection from the sun's harmful ultraviolet rays
- partial stabilization of climate
- moderation of temperature extremes and the force of winds and waves
- support of diverse human cultures
- providing of aesthetic beauty and intellectual stimulation that lift the human spirit.

And how (for instance) are you to know which ones of the more than 50,000 earthworms, 50,000 insects and mites, and 12 million roundworms (not to mention the hundreds of thousands of protozoa and algae and billions of bacteria) that live in a cubic yard of soil you will need to take with you for nutrient transfer, decomposition, or assistance in keeping the Moon's air clean? Or which ones you can leave behind? Most of these small life forms, Daily writes, have never been seen, much less studied. This is merely a single example of the many complex decisions that would have to be made to make the Moon livable.

Back on Earth, every road, parking lot, and building places an impermeable, impervious cover over millions upon millions of tiny life forms, each of which has its role in an ecosystem and the maintenance of a clean, healthy environment. Stormwater washing off these impervious surfaces adds biodiversity-threatening pollutants to our waterways. The vehicles that drive on them add damaging contaminants to the air we and all other animals breathe. These kinds of events are taking place everywhere, but perhaps more often in Florida than almost anywhere else in the nation.

Florida spends a great deal of money on environmental repair — buying environmentally endangered lands, or attempting to control exotic plants on our lands and in our waters, or cleaning up ground water contaminated by thousands of leaking underground storage tanks, protecting the endangered manatee, or attempting to mitigate the loss of wetlands to development. The effort to repair Florida's Everglades[14] will require untold millions of dollars. *Ecosystem Management*[15] is one way Florida is attempting to protect its remaining natural biodiversity — through development of greenways, private and public initiatives for land stewardship, and other actions. Action to conserve our biodiversity will reduce future environmental and economic costs.

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[14] See: *Success in the Making: An Integrated Plan For South Florida Ecosystem Restoration and Sustainability*. The Working Group of the South Florida Ecosystem Restoration Task Force. April 1998. Also: *http://everglades.fiu.edu/taskforce/*

[15] See: *http://www.dep.state.fl.us/ecosystem/*

4. Threats to Florida's Biodiversity

In the years since Florida's statehood in 1845, most Florida ecosystems have been severely modified. Genetic diversity is lower. Many species of animals and plants that lived here back then area extinct. And as we have seen, nearly 120 animals and 500 plants hover on the brink of extinction. The major threats to Florida's biodiversity are:

- **Habitat modification and fragmentation.** Fragmentation of habitat reduces its resilience and increases the possibility of chance extinction. Many of our wetlands, and most of our coastal ecosystems have been modified; our forest cover has declined (most of the original longleaf pine forest habitat in north Florida has been changed to slash pine, adversely affecting the other plants and animals — most notably wire grass and the red cockaded woodpecker — that depended on longleaf pine habitat). Overall, forest cover in Florida has declined from about half the state to less than one third.[16]

- **Introduced species.** There are now about 1,000 exotic weed species in Florida, infesting more than a million and a half acres of land. Vertebrates — several kinds of tropical fish, parakeets, giant snails, walking catfish, domestic cats, goats, feral pigs, and most recently, a voracious fresh water eel that also 'walks,' are established as pests in Florida. Exotic species multiply and dispossess native species or damage native habitat.[17] They thrive because few predators or diseases came with them to control their explosive growth. Attempts to control the exotic *Maleleuca* tree in the Everglades are proving to be costly.

- **Exploitation.** Over pumping of ground water lowers ground water levels and dries out lakes and wetlands, destroying the ecosystems found in those habitats. Over pumping also leads to salt-water intrusion, which destroys the usefulness of the fresh water aquifer. Extensive grazing, logging, or mining of certain ecosystems or habitats has reduced biological diversity throughout Florida. Many salt water fish stocks are badly overexploited. Drainage — for land development, agriculture, or mosquito control — destroys wetlands that are home to rare birds, threatened amphibians, and other important animals and plants.

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[16] *Strategic Assessment of Florida's Environment*, Department of Environmental Protection.1994 *http://www.fsu.edu/~cpm/safe/safe.html).*

[17] *An Assessment of Invasive, Non-indignous Species in Florida's Public Lands*. Department of Environmental Protection. 1994

- **Water pollution.** Water pollution causes local, severe effects such as degradation of fresh water ecosystems by oils and greases and excess nutrients from stormwater. Petroleum and toxic wastes contaminate ground water and often have adverse effects on surface ecosystems.

- **Air pollution.** Emission of the so-called greenhouse gasses (including carbon dioxide and methane, among others) contributes to the possibility of long-term climate change[18] and its adverse effects on coastal and other ecosystems. If sea level rises (for example) even a fraction of some of the predictions, the storm-surge effects of hurricanes and severe winter storms will increase over what can occur today. A rising sea level also could have adverse effects on coastal ecosystems. Rising seas would flood and eliminate coastal wetlands, which, because of intense development just inland from the coastline, might be unable to keep pace with the changing sea levels.

One factor in common to all these threats to Florida's biodiversity is the state's explosive growth. At Statehood in 1845, Florida could claim only a few more than 70,000 people. In the 120 years between 1830 and 1950, Florida grew by less than 3 million new residents. Then, in the 40 years between 1950 and 1990, more than 10 million people flocked to Florida! In 1970, 6.7 million people lived in Florida. Today, Florida has more than 15 million residents. Florida is the nation's fourth most populous state.

The inefficient management and use of biological resources, undervaluation of ecological systems, and lack of awareness are other major contributors to the loss of Florida's biological diversity. Development that only looks at human needs (or wants), without considering the needs of nature, plants and animals, is a major problem.

[18] See: *http://www.dep.state.fl.us/ecosystem/enved/docum/climate.html*

5. Stewardship: Managing the use of the land

One way to protect biodiversity is through good planning and management of our land, air, water, and biological resources. Planning and management are adjustable; they can be implemented on different scales — statewide, regional, and local.

Examples include:

- **The development of *science-based* policies for the management of Florida's biological resources.** Examples include avoiding pest- and disease-prone monoculture agriculture, including forestry; managing fisheries in accord with the principles of population biology; and fully recognizing the importance of water to Florida's native ecosystems — that, for instance, in nature, there is no *wasted* water; the water that flows to the sea is needed and is used by estuarine ecosystems. (Even flooding serves useful ecological purposes: depositing fertile sediments over river floodplains, and dispersing plants and animals in the floodwaters.)

- **Managing entire ecosystems and watersheds.** The simplest example includes recognizing that human activities near the headwaters of a watershed ecosystem — a wastewater discharge, or nutrients washing off from agricultural operations — can have effects far downstream, including in the estuary into which the stream empties. Management of the Apalachicola River system is by a consortium that includes three states and the federal government, and involves several municipalities, and regional governments. The Ecosystem Management work being done in the Hillsborough River Ecosystem Management Area exemplifies a holistic approach to watershed management. Teams consisting of public and private members are looking at the entire picture for the watershed — its air, its lands, its waters and its biological and human resources.

- **Regional, cooperative approaches to the identification and management of protected areas.** An example is the management by state and federal agencies (with strong local involvement) of the Florida Keys National Marine Sanctuary[19]. Sanctuary staff devoted months of effort in the development of a management plant that involved affected agencies, organizations, and the public at large. The result is that an endangered

[19] See: *http://www.nos.noaa.gov/nmsp/fknms/*

Florida ecosystem — the coral reefs of the Keys — receive much more protection than in the past.

- **Conserving native vegetation** is an important part of stewardship. Native vegetation is at the root of a natural ecosystem. Native vegetation helps assure good water quality, maintains soil stability, and provides habitat and food for native species of animals. A great deal of effort is being spent on protecting and restoring native vegetation in Florida. Examples include:
  - The upgraded sewage treatment discharges to Tampa Bay that resulted in improved water clarity, and allowed native sea grasses to return.
  - Work aimed at protecting the Florida Keys lobster (*Panulirus argus*) fishery, which is dependent upon a healthy habitat for its juvenile stage — a habitat that consists of the sponges and native submerged vegetation in the Keys and Florida Bay.
  - Statewide efforts to control or remove nuisance exotic plants and animals from Florida's ecosystems.

6. What can *we* do?

As individuals, we can help conserve Florida's ecosystems and its biodiversity through individual acts of stewardship — things that any citizen can do with little effort, and that add up. The Department of Environmental Protection has developed a series of *Environmental Citizenship* publications (see below) which provide details on many of the actions Florida citizens can take to protect their environment, at home, at work, at school, at play, and on the road.

Here are some suggestions:

- Rather than growing a lawn, let some of your yard go naturally wild — for wildflowers and to attract butterflies and birds.
- Landscape your yard with native vegetation. You'll use fewer pesticides and less water — and attract birds and other wildlife.
- Compost. Dispose of garden wastes and as much as possible of your household food wastes (except meats and fats) by composting. (Meats and fats will turn rancid and attract flies and other vermin.)
- Protect wildlife by controlling pets — for example, fitting cats with collars and bells, neutering pets, and keeping them inside at night.
- Use environment-friendly cleaning agents — for example, phosphate free detergent, or a homemade, general purpose cleaner. [20]
- Recycle or carefully dispose of packaging materials — especially plastic film and beverage containers. Rubbish can kill wildlife. Better yet, avoid products that come with excess packaging — unnecessary plastic shrink wrap, or large and colorful packages whose only purpose is to catch the eye,.
- Conserve energy. By being frugal with how you use electricity — through the use of energy-efficient lighting and appliances, monitoring your use of hot water, and following the recommendations of a home energy audit (offered by most electrical utilities) — you help reduce the need for construction of more polluting electrical generation facilities. Look for products with the *Energy Star* or *Green Lights* logos, and study the energy ratings labels on large appliances.
- **Drive less**. Driving a private car is probably the average Florida citizen's most polluting activity.
- Make 'minimal impact' visits to state and local parks and natural lands. Take care with campfires, and do not collect plants or animals without permission from the agency that owns or manages the land.

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[20] Write the Department of Environmental Protection's Office of Environmental Education (3900 Commonwealth Blvd., MS 30, Tallahassee, FL 32399-3000) and ask for the poster: *Know Your Chemicals*.

- Help protect fish and wildlife. On a good day for fishing keep only what you need. Angler or hunter ethics includes the idea of bringing home *only* what you need for food, then enjoying catch-and-release fishing, or hunting with a camera in order to protect the resources and leave more for others to enjoy.
- Make your voice heard. Respond to management and planning proposals that affect natural habitats in your community or neighborhood.
- Join a group to help with conservation. Examples include local garden clubs or the local chapters of national environmental groups, such as the Audubon Society or Sierra Club.

The Department of Environmental Protection publication, *Ecosystem Management Around the Home*,[21] contains a large number of environmentally responsible things you or your students can do to protect biodiversity or reduce pollution. For students who are driving, *You, Your Automobile and Your Environment*, also available from the Department, offers additional tips and suggestions. The *Environmental Citizenship Handbook*[22] contains a large number of tips for environmental living, many of which deal (directly or indirectly) with biodiversity. *Greening Your Workplace* provides a number of suggestions about making offices and other work areas environmentally friendly.

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[21] Available from the Department of Environmental Protection's Office of Environmental Education (3900 Commonwealth Blvd., MS 30, Tallahassee, FL 32399-3000, or at *http://www.dep.state.fl.us*.

[22] On the WWW at: *http://www.dep.state.fl.us/ecosystem/enved/educators.htm* Click on 'Florida Enviropage.'

Part II
Biodiversity Activities for Students
Grades 6-10

1. What is biological diversity?

Goal: To understand the concept of biodiversity and its many meanings.

After students have read the Introduction, including *Florida's Damaged Ecosystems* and the definitions of biodiversity, ask them to write a paper on biodiversity.

Some questions that might be considered: Where do *humans* fit into the biodiversity picture? Are we part of biodiversity, or are we separate from it? Do we affect biodiversity? How? What specific activities affect biodiversity in our community, or state? How about nationally, and globally?

Is it important to protect *local* biodiversity? Why? Expand these answers to cover biodiversity in the community, statewide, and globally. How should we act to protect biodiversity? Do any endangered species live near your community?

Other ideas. Ask a group of students to brainstorm other topics that are aspects or examples of biodiversity — butterflies with different wing patterns, floodplain forests along the Apalachicola River and Everglades wetlands, and people with blue eyes and those with brown, and great danes and toy poodles.

Who is E.O. Wilson? Assign a student or group of students to read *Naturalist*,[1] Wilson's autobiography and report back to the class with an outline of Wilson's life and work. A group of

[1] Wilson, E.O., *Naturalist*, Island Press (?) 199X.

students who are taking biology might read Wilson's *The Diversity of Life*,[2] the book in which he first coined the word and first brought the biodiversity crisis to the public eye.

Biodiversity on the Internet. Another group might search the World Wide Web and produce a list of useful Web sites and other Internet resources that deal with biodiversity. The list should include a brief assessment of each site.

[2] Edward O. Wilson, *The Diversity of Life*. W.W. Norton & Co., 1993.

2. What do *you* get from biodiversity?

Goal: To identify and explore some of the benefits of biodiversity, and the sources of these benefits.

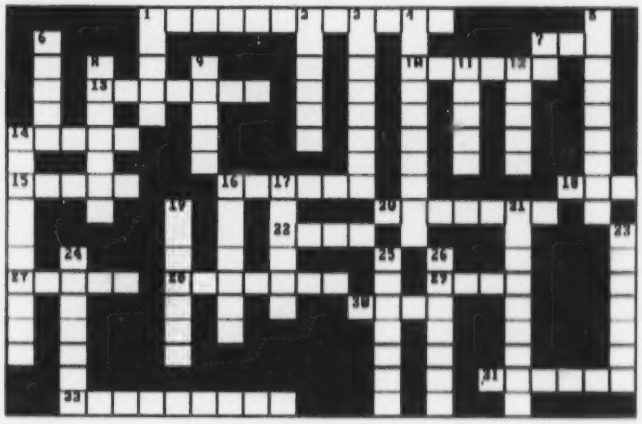
Have the class brainstorm a list of possible benefits of biodiversity. (It will help if some of the class members have read one or more of the books listed in the previous section, or below.[3] Or, using ***Inference Find***, (*http://www.inference.com/ifind*) or ***Web Ferret*** (available free at *http://www.ferretsoft.com*), a student or group of students should search the World Wide Web for articles on the **benefits** of biodiversity. Each list of 'hits' gathered in different searches should be printed out.)

Ask students to identify how biodiversity might contribute to each of the benefits they identify, and what might happen if biodiversity could no longer provide one (or any) of these benefits? Each student should select one of the benefits for further research and write a paper outlining how biodiversity contributes, and how this benefit would be affected if biodiversity was reduced.

[3] **Note to Teacher**: The Ecological Society of America publishes a series of papers called *Issues in Ecology*. In the spring of 1997, it published Number 2 in the series: ***Ecosystem Services: Benefits Supplied to Human Societies by Natural Ecosystems***. Write the ESA at: Subscriber Services, 2010 Massachusetts Avenue, N.W., Suite 400, Washington, DC 20036. The cost is $3.00. Or download it (free) from: *http://www.sdsc.edu/~ESA/issues.htm*

3. The *Words* of Biodiversity

Goal: To introduce the meanings of some ecological and biological terms.



ACROSS

1. The variety of life on earth
7. Endangered Species Act (abbrev.)
10. An area where an organism is protected and safe
13. A productive coastal area where fresh and salt water mix
14. A bird; a success story for the endangered species act
15. A pollutant at ground level; in the upper atmosphere, it protects against ultraviolet radiation
16. They ARE part of the ecosystem
18. Department of Environmental Protection (abbrev.)
20. A marine mammal and endangered species
22. Florida gets more than 50 inches a year
27. Threatened tropical marine ecosystems with high biodiversity.
28. A species not found in the wild for at least 50 years
29. Large American reptile; an endangered species (abbrev.)
30. Extinct flightless bird
31. The study of plants
32. Contamination of air, water or land

(Answers: Page 40)

DOWN

1. All living organisms in an area — plants and animals
2. An introduced, non-native species, frequently a pest or weed
3. Enlightened managers of land and water resources
4. Of the land
5. These coastal wetland systems have high biodiversity
6. The plant life of a region
7. Environmental Education (abbrev.)
8. Marshes are these
9. A geographic area in which rainwater collects and drains via streams and rivers
11. The animal life of a region
12. Large American reptile; once an endangered species (abbrev., or nickname)
14. Combines travel with environmental education
16. The part of an ecosystem inhabited by an organism or population
17. Of the sea
19. Found only in a certain region
21. Environmental _____. Teaching about the natural world around us
23. The study of the relationships between organisms and the environment
24. To modify the land to satisfy human needs
25. The study of animals
26. A clean environment is necessary if we are to have a healthy _____.

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4. What can we as individuals *do* to protect biodiversity?

Goal 1: To encourage specific actions to conserve biodiversity.

Give students copies of the DEP's *Ecosystem Management Around the Home*[4] publication. After they have had a chance to read it, divide them into groups and ask them to discuss which suggestions might affect biodiversity, and how. Then, ask them to discuss their favorite suggestions, explaining why they think these are good ideas. The groups might list which suggestions might be beneficial for the school, or for their neighborhoods.

Some issues may have similar solutions. Discuss why.

Groups might undertake a commitment to follow through on a specific suggestion (or suggestions) and report back to the class at intervals on how they are carrying out their commitments and what their savings were — in terms of water, energy waste reduction, etc. The class can maintain a progress chart to be updated after reporting sessions.

Ask class members to take copies of *Ecosystem Management Around the Home* and discuss the options with their families. Some students and their families may already be doing some of these actions. Ask them to share their experiences.

Goal 2: To promote individual conservation action and explore ways the community can conserve biodiversity.

The community is not just made up of individuals, but includes many groups, associations, and organizations — the fishing industry, farmers, miners, loggers, manufacturers, business people, and others. Ask individuals or groups of students to chose a community group and learn how those groups might affect biodiversity and what actions members of that group might take to help preserve it.

[4] Available in quantity at no charge from the Office of Environmental Education, Department of Environmental Protection, 3900 Commonwealth Blvd., MS 30, Tallahassee, FL 32399-3000.

5. An Ecosystem or Biodiversity Time Machine.

Goal: History — to explore the concepts of change, variation, and adaptation in ecosystems.

Writing: Ask the class to imagine what the landscape around the school might have looked like in the past, or may look like in the future. Separate groups should work on each scenario.

The group which looks at the past can read about local history and geography to determine how the land was used. Longtime residents of the neighborhood or the community in general can be interviewed. Perhaps there is a local history at the Public Library. Many communities have a local historical society, or other organization interested in historical preservation. Old maps — land use or zoning maps, or older U.S. Geological Survey quadrangle maps of the area will show former land uses. Prepared a detailed report to the class.

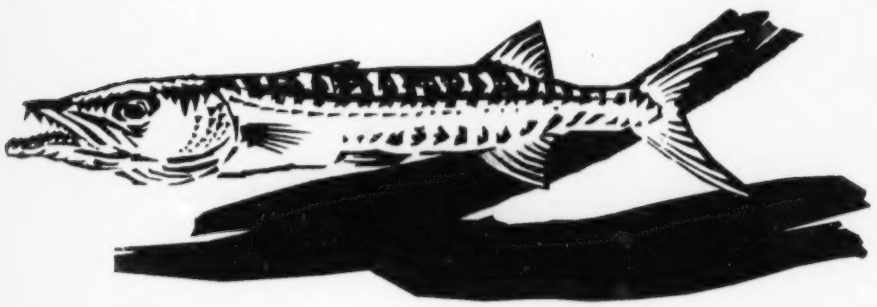
Another group might write about the biotic history of their community. What was its environment like 10, 20, or 50 years ago? What is gone? What remains? What is here now that was not present in the past?

The group looking at the future may be able to use many of the same documents to predict what may happen in the future, or it can study trends in the community as a whole to see where growth and development are moving toward. Students also should examine the current local land use maps and the local comprehensive plan to see what they say about the future for the area. These plans often will be on file at the local Public Library and also will be available at local government offices. A member of the local planning and zoning board may be willing to be interviewed. Members of the local Chamber of Commerce will have their own opinions. Perhaps the president or executive director will share his or her views. Prepare a detailed report to the class.

Suggested time frames: **Past**: 10, 50, and 100 years ago. **Future**: 10, 15, 20, and 100 years from now.

Art: Groups of students might create a mural, with panels depicting the school landscape 1,000,000 years ago, 1,000 years ago, 100 years ago, 20 years ago and today — and even carried into the future (work with the writing students). The mural should indicate the major forces that

shaped the landscape for each period — not forgetting humans as a major shaper of landscapes. Students should be prepared to discuss each panel.



6. Keeping informed about biodiversity.

Goal 1: To encourage awareness of current biodiversity issues.

Social studies: Discuss with students that even though the word *biodiversity* is seldom heard on TV and seldom appears in media articles, most issues in the news that deal with conservation and the environment, land use and management, farm management, new breeds of plants and animals (and new ways to produce domestic animals, such as cloning), genetic engineering, ecotourism, pest control (including biological control as well as chemical control), development, and many other subjects are, in fact, very relevant to discussions about biodiversity. Ask students to brainstorm a list of *key words* relating to biodiversity.

Then, using these key words and others they may think of as the project continues, ask them to watch for articles in newspapers and magazines, on television, and on the Internet's World Wide Web that have some relationship to biodiversity. Students should keep scrapbooks. Materials on television should be recorded as to date and time of broadcast, and the station and network (if any) over which it was broadcast. Articles in newspapers and other publications may be clipped, or copied. Web home pages should be printed out and their URL (address) should be part of the printout (the "Printer setup" menu should provide this setting with the WWW browser).

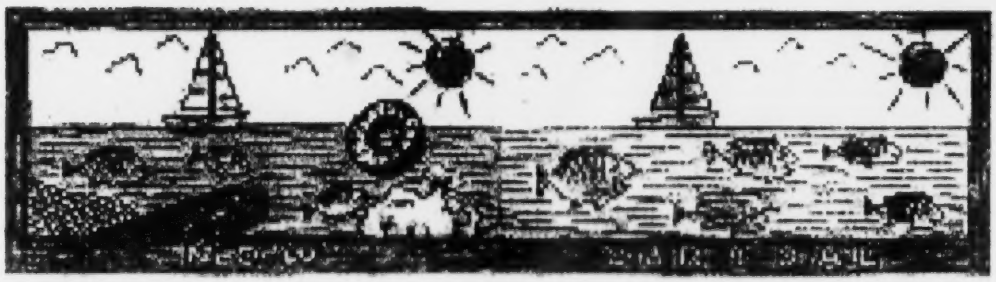
Goal 2: To encourage understanding of important biodiversity issues.

Ask students to do individual research and an essay on biodiversity related topics or case studies.

Possible topics (there are *many* others):

- Importance of genetic diversity to agriculture (corn may be an example, although there are others — not all of them plants.)
- Impact of feral animals on biodiversity.
- Endangered species.
- Fish stocks, management, and commercial and sports fishing.

- Global climate change and biodiversity.
- Cycles (water, carbon, nitrogen).
- Significance of Florida's biodiversity to its economy.
- Managing domestic pets
- Exotic plants.
- The effects of genetic engineering on biodiversity.
- Costs of environmental cleanup and repair.



7. Neighborhood biodiversity.

Goal: To investigate local examples of biodiversity and to encourage students to take a closer look at the biodiversity around them.

Required tools: String or cord (20 feet), stakes, hammer, pens, graph paper, tweezers, collecting jars, magnifying glass or microscope, and various field guides for identifying local plants, microorganisms (optional for advanced students), and animals.

Procedure: Select 3-4 accessible areas (the schoolyard, a local park or greenway, or a state park, creek bank, field or pasture, etc.) to survey and count the numbers of species of plants and animals found on small plots of land there. Ask different students to select different ecosystems or habitats (upland site, shoreline site, north-facing slope, south-facing slope, etc.). Point out that the number of different kinds of species they see are only an *indication* of the biodiversity of each site and that there will be many other, unobserved species that live on the site — such as microorganisms, animals on the move, or nocturnal animals.

To conduct the survey, students can map a transect or count species in a 5 meter square area.[5] Surveys are just one of the ways to measure biodiversity. Compare findings and ask students to propose reasons for the differences in biodiversity between sites. The class might create a collective field guide to the plants and animals of whatever site the class selected.

[5] See: *Classroom and Field Experiments for Florida's Environmental Resources*. Florida Department of Environmental Protection, Office of Environmental Education.

8. Florida Made

Goal: To look at the cultural significance of Florida biodiversity.

Definition: Symbol or Logo — something used or regarded as standing for something else. .

Show students examples of symbols or logos incorporating Florida animals or plants, and ask why they think these symbols were chosen to represent those organizations or concepts.

(several of Florida's specialty motor vehicle license plates shown here (as well as its regular plate) carry symbols of Florida's biodiversity.) The Florida State Seal (also shown) also contains symbols representing aspects of biodiversity.

Many companies use biodiversity-related symbols in their company logos.

Ask students to collect and bring in pictures of logos and symbols from magazines, sporting organizations, food labels, stamps, etc. that have a biodiversity theme.

Students might pick their favorites from those collected, and answer the following questions:

Why is this your favorite ecological logo or symbol? What does it represent, and what is its relationship to the product or organization that uses it? What qualities make it a good logo or symbol for what it represents? If the logo features a Florida species, where will it be found in nature? Is it rare, or threatened? if so, what is being done to conserve it?

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Extension: Art/Social Studies — Ask students to choose a native Florida plant or animal to become a symbol to represent a particular biodiversity issue of their choice (protecting habitats, endangered species, land care [stewardship], exotic species, prevention of trade in endangered species, etc.) .

Florida State Seal

Using their selected species, students can design a logo, and develop an outline of a political or public relations campaign designed to convince people — using the logo in some prominent way — that the selected issue is import to them.

9. Improving Campus Biodiversity

Goal: To promote local biodiversity through active teamwork.

Ask students to design and undertake a project to increase biodiversity of the school grounds.[6]

Procedure:

- Select a section of the school grounds and brainstorm ways the area can be improved and its biodiversity increased.
- Draw up a list of specific objectives for the project. Examples: To plant 10 locally native trees, 20 locally native shrubs, and 30 locally native grasses to encourage wildlife (including butterflies). Plan for whole plant communities.
- Present the plan to, and **obtain permission** from the school administration to undertake a project on this site.
- Mark out the area (and fence it off if possible and necessary).
- Make an inventory of all existing species (native plants as well as exotic plants that should be removed) and the soil conditions, light and shade, and moisture levels. Map the site as it exists when you start.
- Consult local experts — The Florida Game and Fresh Water Fish Commission, a local nursery that specializes in native plants (see the Association of Florida Native Nurseries Internet's World Wide Web site [*http://members.aol.com/afnn/*].), your local county agricultural extension office (the Florida Enviropage (*http://www2.dep.state.fl.us/enviropage/html/org.htm#4*), or a local garden club.
- Drawing upon your inventory and advice from local experts, make an action plan for the project. Break the plan into stages and list actions for each stage. Don't forget to include ongoing monitoring. Determine costs for each stage and work out time requirements.
- Draw a map of the site, showing where you plan different parts and different plants.
- Allocate group and individual responsibilities and tasks. Work out cost-effective ways to achieve the plan (donations, voluntary work, etc.). Ask for help from parents and the local

[6] **Recommended**: *The Schoolyard Wildlife Activity Guide*, *Schoolyard Ecosystems for Northeast Florida*, and *Handbook of Schoolyard Plants and Animals of North Central Florida*. All available from the Florida Game and Fresh Water Fish Commission.

community. Determine costs for each stage and work out time requirements for each. Plot these all out on a Gannt chart which can be placed on a schoolroom wall.

- Begin by photographing the site and then remember to photograph it throughout the course of the project, at the end of each stage, and at various seasons of the year after it is completed.
- Monitor progress, making records before, during, and after each stage of the project. *Celebrate at the end of each stage!*
- Evaluate the project six months after completion, doing another assessment of plants and animals found at the site. Has the project increased biodiversity, and to what degree? Have some plants died? Have any unlooked-for species appeared? Are any of the exotic species returning?
- **The Future** — Leave a detailed manual for classes that follow, describing what was done, what is yet to be done, how the site should be maintained, and how to incorporate it into *their* biodiversity activities.
- **For teachers**, or as a class or school-wide exercise: Develop a permanent environmental curriculum based around the newly renovated site. This will provide for perpetual maintenance and will allow the site to become a continuing part of your ecosystem and biodiversity activities at school.

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10. Schoolyard Ecosystem or Biodiversity Day *(This activity is suitable for all K-12 grades.)*

Goal: To promote information and awareness about the importance of Florida's ecosystems and biodiversity.

Ask students to plan, promote, and carry out a day of activities focusing on ecosystems and biodiversity. The activity might be planned for on or near Earth Day (April 22 annually).

School Day Steps:

• Get support from school administrators and other teachers to make this a school-wide Ecosystem and Biodiversity Day.

• Class by class, brainstorm the types of ecosystem and biodiversity messages that should be delivered. Each class might adopt a theme — Stewardship, Pollution, Natural Resources Management, National Parks, Ecosystems, Native Gardens, Native Species, Exotic Species, Managing Domestic Pets, Endangered Species, Cycles (water, carbon, life), and others.

• Brainstorm the types of activities or displays that will be effective ways to promote information and understanding about the chosen themes.

• Allocate jobs and responsibilities to classes, and within classes to groups or individuals. These might include preparing exhibits or displays, publicity, and liaison with teachers and parents. *Don't forget evaluation.* You should evaluate what worked and what did not work. What caused the most debate? What was most popular? What was too much trouble to do again? Would you have the day again?

Some activity suggestions

Elementary Grades:

- Make posters on biodiversity topics. Place them around school, with a student at each to explain the poster.
- Write and produce a biodiversity drama and present it during the lunch hour.
- Create orchestral instruments from things that a related to biodiversity — seed shakers, leaf rustlers, water trickling from bottle to basin, shell rattlers, whistles make from grass stems — and perform a piece of music.

Middle School Grades:

- Organize a biodiversity poetry competition. Winners can recite their poems at lunch time, at an assembly, or some other time during the Biodiversity Day Celebration. Winners poems should be collected and published.
- Prepare placards to hang around the campus. The placards should contain biodiversity riddle clues to common schoolyard and schoolroom items that are made directly from natural resources (examples: chalk, paper, wood rulers). How may the manufacturer of this product have affected the biodiversity of the area from which it came?
- Draw a treasure map to where examples of these products may be found.
- Ask students to identify what ecosystems the products came from and hold a competition for the correct answers. A suitable prize for the winner might be a seed or seedling of a native tree — which can be planted at her house or at school.
- Construct biodiversity food web mobiles to demonstrate interconnections.
- Appoint photographers and press reporters for the day to record the activities for a school paper and also for evaluation and planning for next year.

High School Grades:

- Prepare biodiversity campaign speeches to be delivered from soapboxes at various points around the campus.
- Organize a biodiversity poetry competition. Winners' work will be published by the school, and winner may recite their poems some time during the day.
- Contact the local press and arrange a biodiversity-related photo story for them — perhaps using a habitat students have worked on (see previous exercise), or some other activity, as the basis of the story.
- Arrange for outside experts to come to the school to talk on biodiversity topics.
- Develop interpretive signs and post them around the campus, explaining the good and bad points of biodiversity on the school campus. Conduct tours around high and low biodiversity sites on the school grounds. Point out where materials used in the school's construction or as school supplies have negative or positive connotations for biodiversity issues.
- Prepare models of some vital ecosystems — wetlands, estuaries, mangroves, rain forests, deserts. Use scrounged and recycled materials to make the models — nylon stockings, cardboard, plastic containers, and packaging, and use them to explain the value of recycling and reuse.

All grades:

- Create a school biodiversity mural, with each class producing a section to illustrate their biodiversity theme.
- Have a VIP (city or county commission, local legislator) plant a locally endangered native plant species on the school grounds.

11. The Importance of Biodiversity

Goal: To explore personal feelings and impressions about conserving biodiversity. *(Best done as the final exercise.)*

Ask students to write poems — in any form (haiku (at least three), sonnet, jingle, limerick, etc.) — or to write a brief (100 word) essay about biodiversity. Other students might consider a photo essay or other artwork (mixed media, drawing, painting, sculpture, ceramics, etc.) that relates to biodiversity in some way that the student is prepared to explain. Whatever format students choose, the work should portray and explain *their* feelings about the importance (or lack of importance) of biodiversity.

Students should share their work with the class. Have the class identify and discuss any common or major themes they discover. Students might note why *they* feel the form — essay, poetry or artwork, or the form of each — they chose was suitable for a biodiversity theme.

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Glossary

Aquatic. Of the water.

Biodiversity (or Biological Diversity). The variety of life on earth. The different plants, animals, and microorganisms, the genes they contain, and the ecosystems of which they form a part.

There are three levels of biodiversity:

- *Genetic diversity* — The variation of genetic material within and between species and subspecies of animals and plants.
- *Species diversity* — The variety of living organisms on earth.
- *Ecosystem diversity* — the variety of habitats, natural communities, and ecological processes on earth.

Biological control. The use of natural agents to control animal pests and weeds and other problems, such as crop diseases.

Biosphere. The total of all the various ecosystems on earth; the spheres of air, water, and land in and on which all life is found.

Biota. All of the living organisms in a specific region or area, including animals, plants, and microorganisms.

Catchment. A drainage basin which collects all the rainwater that falls on it and directs the water to rivers and streams that carry it to a lake or the sea.

Community. A naturally occurring group of different organisms that live together and interact as a unit.

Conservation. The management of the human use of the biosphere to ensure that it yields the greatest sustainable benefit to present generations while it maintains its potential to meet the needs and aspirations of future generations.

Development. The modification of the biosphere and the application of human, financial, and non-living resources to satisfy human needs.

Ecology. The study of the relationships between organisms in their ecosystems with the physical components of those ecosystems.

Ecologically sustainable development. Using, conserving, and enhancing the community's resources so that the ecological processes and relationships upon which life depends are maintained, and the total quality of life, now and in the future, can be increased.

Ecosystem. 1. A dynamic complex of plant and animal communities and their non-living environment. 2. *A community of organisms, including humans, that interact with one another and with the environment in which they live.*

Endangered species. Plants or animals which are in serious risk of disappearing from the wild state within one or two decades if present land use and other causal factors continue to operate.

Endemic. Found only within a certain region.

Environment. The physical, chemical, biotic (living), and social conditions surrounding an organism.

Evolution. The continuous genetic adaptation of species to the environment.

Exotic species. An introduced, non-native species of plant or animal.

Extinct. A species that no longer exists; one that has not been found in the wild for 50 years, despite continued searching.

Fauna. The animal life in a region.

Flora. The plant life of a region.

Habitat. The part of an ecosystem that is inhabited by an organism or population of organisms.

Invertebrate. An animal without a backbone.

Marine. Of the sea.

Natural resource. Any portion of the natural environment, such as air, water, forests, minerals, or wildlife) that can be used for human benefit.

Niche. A position or function in the habitat that provides all the living needs of a species.

Nonrenewable resource. Natural resources that, once used, are lost forever. Example: oil.

Nutrient. A compound necessary for life, such as nitrogen, or phosphorous. Too much nutrient in the water can cause *eutrophication* and fish kills.

Pollution. Contamination of air, water, or soil with some form of matter or energy to an undesirable level.

Species. A group of organisms which are so similar genetically that they can interbreed and produce fertile offspring.

Terrestrial. Of the land.

Upland. An area that is not flooded on a regular basis and that does not support vegetation dominated by plants that depend upon saturated soil.

Vertebrate. Animals with backbones.

Wetland. An area that is inundated or saturated by ground or surface water at a frequency and at durations sufficient to support a prevalence of vegetation typically adapted for life in saturated soil conditions.

Further Reading

A Bibliography of Enjoyable and Useful Reading About the World We Live In.

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Silent Spring. Rachel Carson. Houghten Miffflin. 1962.

The Diversity of Life, Edward O. Wilson. W.W. Norton & Co., 1992.

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Toward Environmental Citizenship. Florida Department of Environmental Protection. 1995.

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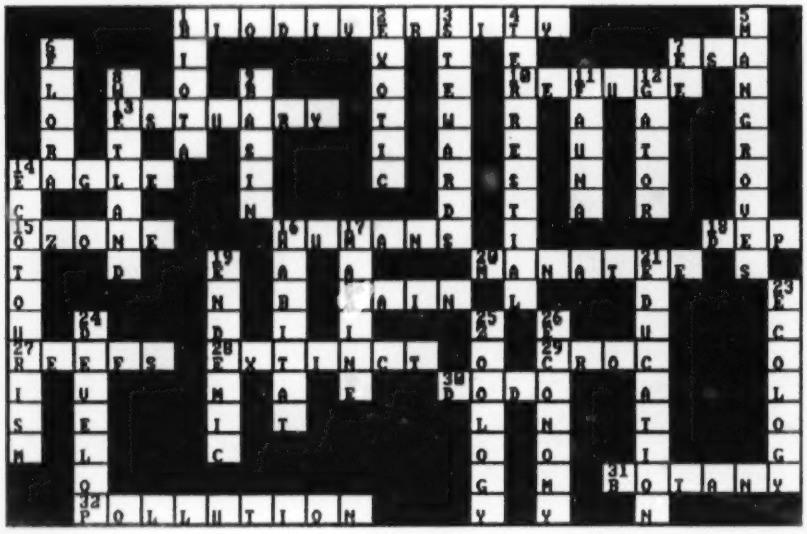
Answers to The *Words* of Biodiversity



Students should check to correct answers and discuss any of the words they missed or whose meanings they are unsure of.

Notes